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AN EVALUATION OF THE NAVY UNDERSEA WEAPONS TANK FOR TESTING AIR--ETC(U)

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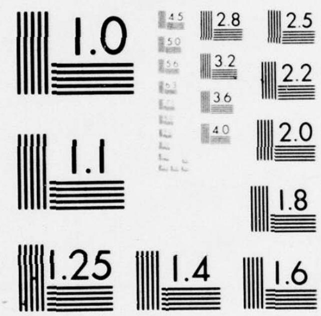
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OFFICE OF NAVAL RESEARCH

12

Final Report

AN EVALUATION OF THE NAVY UNDERSEA WEAPONS TANK FOR TESTING AIRCREW ESCAPE, SURVIVAL, AND RESCUE PROCEDURES AND EQUIPMENT

September 1977

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OFFICE OF NAVAL RESEARCH

9 **Final Report**

6

AN EVALUATION OF THE NAVY UNDERSEA WEAPONS TANK FOR TESTING AIRCREW ESCAPE, SURVIVAL, AND RESCUE PROCEDURES AND EQUIPMENT

by

10 Martin G. Every
Michael C. Brody

15 *Contract No. N00014-77-C-0253*
Task No. 207-007

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FOREWORD AND ACKNOWLEDGEMENTS

This study is part of a program for the Office of Naval Research to examine problems relating to in-water escape and survival of Navy aircrewmen. Dr. Arthur B. Callahan, Director, Biophysics Program, Biological Sciences Division, Office of Naval Research, served as Technical Monitor for the project.

Special thanks must go to the following for their assistance during the project:

Mr. Sam Weinstock, Mr. Leon Norton, and Mr. Rick Moody for their underwater photographic documentation of this study.

Mr. James Martin and Lt. Robert E. Bason, MSC USN, Systems Engineering Test Directorate, Naval Air Test Center, Patuxent River, Maryland, for the use of the parachute and the aircrewmen's personal protective and survival equipment.

Mr. William Dulaney, Mr. Armando Masciantonio, and Mr. Gerald Ellis, Naval Surface Weapons Center, White Oak, Maryland, for their cooperation and engineering support in operating the test facility.

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INTRODUCTION

Escape, survival, and rescue following a Naval aviation mishap often involve underwater or open ocean exposure for both the survivor and the rescue personnel. Whether the in-water escape is from a submerged helicopter, an entangled parachute, or from the cockpit of an aircraft, ultimate survival is dependent on a number of variables, such as degree of injury sustained in the mishap, reliability of survival equipment, emergency training, proficiency of rescue personnel, and the suitability and reliability of the rescue equipment used to effect recovery under a wide range of hostile conditions.

One notable problem area which appears common to all of the above factors is the unavailability or inadequacy of in-water test facilities which can be used safely to evaluate and document the equipment and procedures associated with in-water escape, survival, and rescue. Research involving these issues has often been conducted in makeshift facilities – shallow pools, rivers, lakes, or inadequate test tanks such as the one formerly used at the U.S. Naval Base, Philadelphia, Pennsylvania. These sites often proved unsanitary, unsafe for diving purposes, uncomfortable, and due to poor lighting and turbid water, completely unsatisfactory for visual documentation of the actual test.

The primary purpose of this study is to inspect, evaluate, and document the Naval Undersea Weapons Tank in terms of overall suitability to conduct underwater research relating to the problems previously discussed. This report presents this documentation, much of which was conducted with live subjects involved in parachute entanglement and rescue tests.

DESCRIPTION OF THE TEST FACILITY

The Undersea Weapons Tank is located at the Naval Surface Weapons Center at White Oak, in Silver Spring, Maryland, approximately one mile north of the Washington Beltway at Exit 25. This tank is the only one of its kind in the United States; it is 107 feet high, 50 feet in diameter, and holds one and one half million gallons of purified fresh water (Figures 1 and 2). The top of the tank is enclosed and bordered by upper and lower decks. The lower (operations) deck, which completely circles the tank, is approximately three feet above water level and contains worktables, safety equipment, electrical outlets, and communications stations (Figure 3). Two access platforms extend out into the water. One is at deck level and the other, approximately five feet above water level, is a retractable walkway which may be extended to the center of the tank. The upper (observation) deck is approximately ten feet above the lower deck and circles three quarters of the tank. Much of the (observation) deck space is devoted to tables and power equipment, however, one side is enclosed by a glass partition and wired for electrical equipment and communications (Figure 4). Windows surround both decks and overhead lights provide excellent illumination for surface photography. Because the tank is enclosed, the option also exists to adjust available light to simulate darkened conditions.

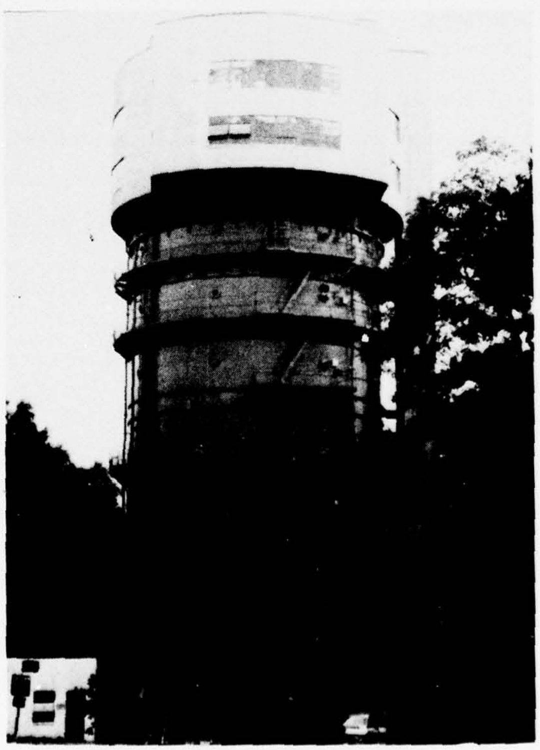

Figure 1. External View Undersea Weapons Tank.

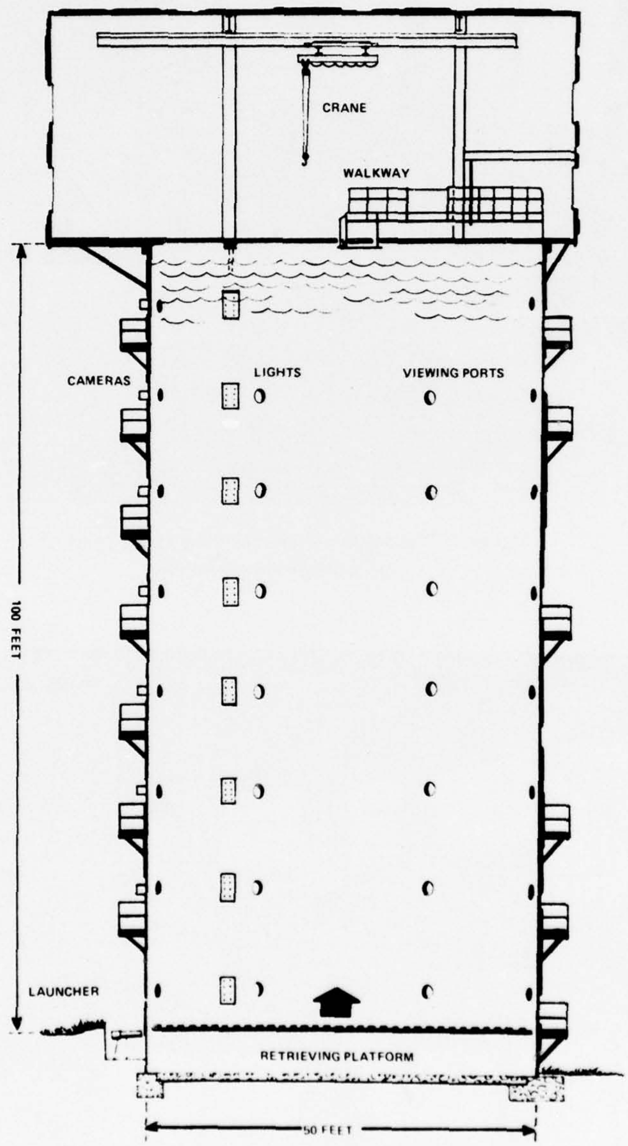

Figure 2. Diagram of Undersea Weapons Tank.

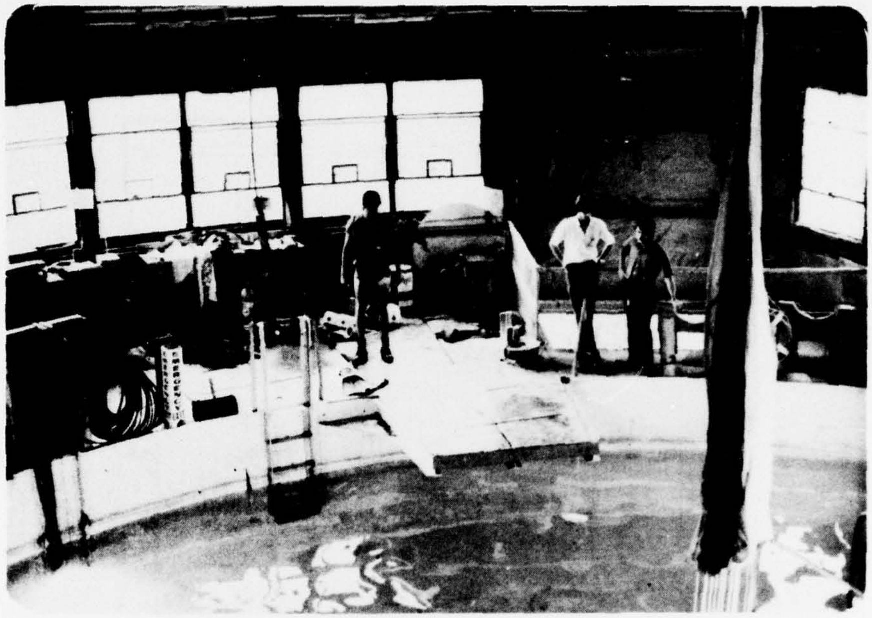

Figure 3. Operations deck, showing entry platform and outside access hatch.

Figure 4. Observation deck control room.

A movable, three ton capacity bridge crane is located above the tank. Maximum clearance between the water surface and the crane hook is 19½ feet. Large objects may be hoisted into the building through a hatch in the floor of the operations deck where it extends out beyond the tank wall. This hatch is six and one half feet by seven feet, which limits the size of objects which can be brought into the building. Mounted outside the tank, at ground level, is a submarine signal launcher which can be used to shoot small objects into the bottom of the tank. An outside elevator provides access to the upper decks for personnel and equipment. Six observation platforms encircle the exterior of the tank with eight viewing ports at each platform. All are connected by an intercom system to the observation deck.

The tank itself is filled with purified, chlorinated fresh water. The most unique feature of this tank is the retrievable floor which can be positioned at any depth from above water down to a depth of 100 feet (Figure 5). This platform can support a maximum static load of 6,000 pounds and an impact load of 1,000 pounds. It can be lowered at a rate of 25 feet per second, and raised at a rate of 10 feet every 18 seconds. The water clarity at all depths is excellent. Figure 6 was shot from 100 feet with available light and clearly shows divers at depths of 80 and 60 feet. The tank has a 16 mm automatic camera system with 14 cameras arranged in two columns, so located that the entire tank from the water surface to the bottom can be viewed. The cameras are operated electronically from a master switch. Illumination is provided by 144 Quartz-Iodide underwater lamps.

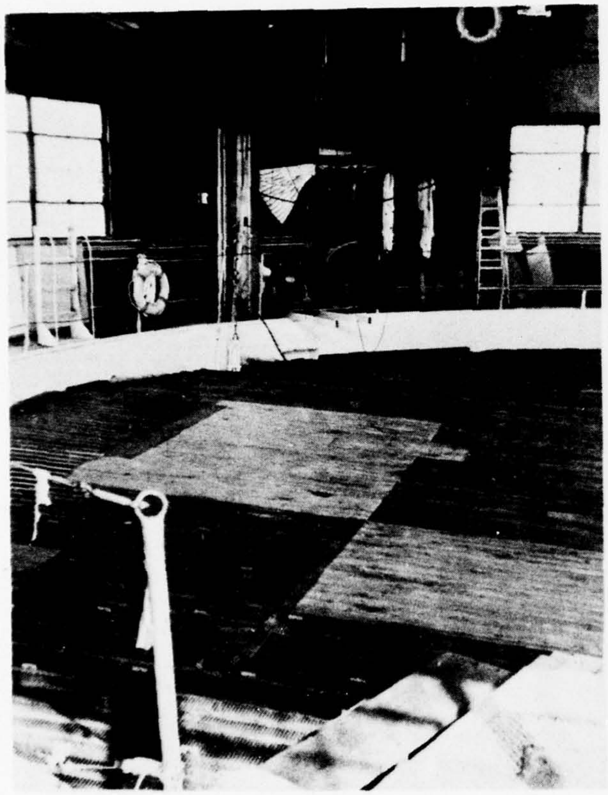

Figure 5. Retrievable floor
in full-up position.

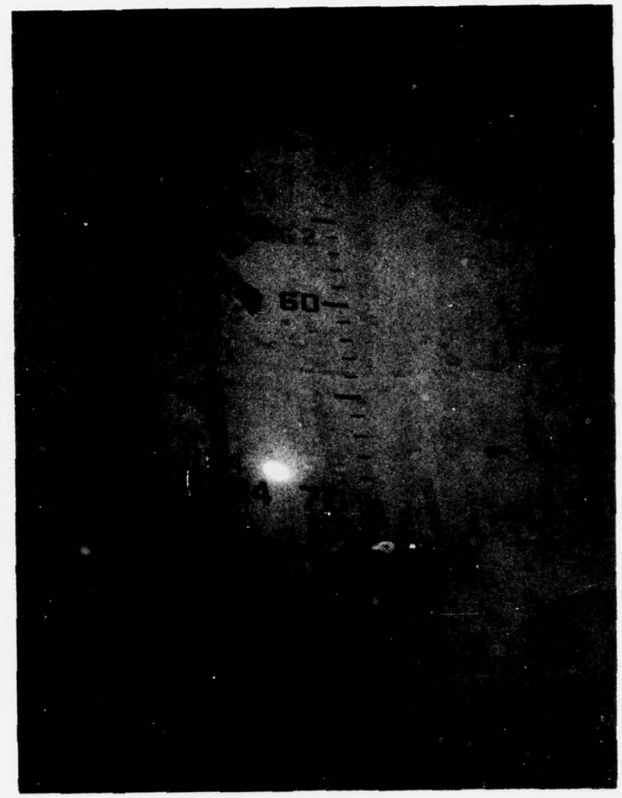

Figure 6. Photograph taken from 100 feet
showing tank water clarity.

IMPORTANT FACILITY CHARACTERISTICS

The following sections will discuss some of the important characteristics which make this tank an excellent facility for conducting safe, well-documented, in-water research.

Safety Features

Safety is always the primary consideration whenever live subjects are involved in underwater research. The most important safety feature associated with this tank is the movable floor which may be used in conjunction with the overhead crane to rapidly recover a specific underwater object or an entire project. On signal from project personnel, the facility engineer can bring the floor from a depth of 30 feet to the surface in less than 60 seconds. The floor can also be set at a depth of eight feet, for example, and then brought to a safe level of three feet in less than ten seconds. The overhead bridge crane can serve as a back-up to the system or be used for quick retrieval of any single object.

The purity of the water in the tank is important from a general health aspect and because it allows good visibility. With the in-water Quartz-Iodide lights turned on, safety divers and porthole observers can readily observe test subjects located at any position within the tank. Topside communication stations can be linked directly to porthole and underwater communication units. This allows safety personnel to be fully aware of underwater activities and to react instantaneously should an emergency occur.

Physical Advantages of the Test Site

The proximity of this facility to the Washington, D.C. area offers the opportunity for interested, non-project personnel to view various tests, without extensive travel or time requirements. Because the tank is completely enclosed, it can be used almost year-round without delays from unexpected or extreme weather. The lower deck work space is wide enough to permit storage of large amounts of diving and project support equipment while still allowing ample space for project work near the water's edge. The outside elevator is located near a vehicle loading area, so heavy diving equipment can be easily loaded and unloaded. Very large equipment can be hauled up directly from an open truck, through the operations deck hatch, utilizing the bridge crane. This tank allows test divers to make actual wet dives to depths of up to 100 feet to test the effects of pressure on equipment, eliminating many of the space constraints associated with simulated pressure chamber dives.

Data Recording and Communications

The purified fresh water found in this tank is less corrosive to sensitive test gear than salt water. Additionally, it provides good underwater visibility for video documentation. The Quartz-Iodide underwater lamps provide excellent underwater lighting for video tape equipment, mounted 16 mm automatic camera systems, and diver hand-held 35 mm cameras. The glass-enclosed office on the observation deck is ideally suited for closed circuit television monitoring and general project management. From this office, selective or open communications with divers, facility engineers, and deckside personnel can be provided.

The facility's electronic and telecommunication systems permit computer adaption to monitor and record test information, such as physiological data, for instantaneous analysis. The retrievable floor, raised above the water surface, simplifies deployment and enables secure anchoring of the data recording equipment. It also permits modifications of test equipment, changing of film, and repair of equipment in a dry environment.

Emergency Medical Care

Within the immediate area of the Undersea Weapons Tank are emergency first-aid units associated with the Naval Surface Weapons Center. This facility, however, is extremely unique in being only minutes away from the underwater medical facilities and personnel associated with the Naval Medical Research Institute (NMRI) in Bethesda, Maryland. This branch of NMRI is equipped with several modern recompression chambers and is staffed by medical experts in the area of diving medicine and treatment of diving accidents.

FACILITY EVALUATION PROGRAM

The optimal technique to evaluate the capabilities and safety aspects of this weapons tank was determined to be the utilization of actual tests involving human subjects performing under the stresses of underwater parachute entanglement. The specific problem was to evaluate a short-duration underwater breathing system designed to aid in rescues where parachute entanglement occurs.

For these experiments, all divers were either Navy-qualified or possessed the equivalent civilian training. The program director was a Navy Underwater Demolition Team qualified diver. Both underwater photographers and the safety diver were qualified scuba diving instructors. During all in-water experiments, both photographers and the in-water safety diver were equipped with a Scuba Pro Mark V Octopus regulator which contained an auxiliary regulator to supply emergency air to any subject or project person who experienced difficulty underwater. These divers were also equipped with buoyancy control vests which, in addition to serving as emergency life vests, were capable of raising to the surface up to three people on each vest. Each diver was equipped with an automatic decompression meter, designed to keep track of decompression time on an individual basis. These served only as a back-up to the decompression time calculated from the U.S. Navy Diving Tables by the project diving officer.

Previous studies by BioTechnology, Inc. and other researchers in water survival and rescue of downed aviators have shown the severe consequences associated with in-water parachute entanglement. Often this entanglement is responsible for either drowning a survivor or greatly jeopardizing the safety of rescue crewmen. To aid the helicopter rescue crewmen, BioTechnology, Inc. developed a prototype, limited-breathing apparatus, rescue vest which would assist the rescue crewmen during the rescue and recovery operations. This vest (Figure 7) is a lightweight, neutrally buoyant, fast-donning unit which will not adversely affect the stability of an aircrewman when jumping from a helicopter. It has a one pin fastening device which allows it to be put on or removed easily and quickly. The back of the vest contains two small air tanks (Figure 8) which provide the rescue crewmen with ample air to accomplish underwater parachute disentanglement, aid in escape from a submerged helicopter, and minimize breathing problems caused by rotor downwash from the rescue helicopter. The air tanks are covered with a lightweight fiberglass backpack which prevents in-water entanglement with parachute shroud lines. The front of the vest contains a clip-on device for secure storage of the scuba regulator mouthpiece, a high intensity strobe light, packets for two Mark-1 Day/Night flares, a knife or shroud cutter, and a pocket which contains a CO_2 inflatable flotation device which can be used to retard sinking of the parachute and/or aid in providing buoyancy to a survivor.

Figure 7. Front view of rescue vest.

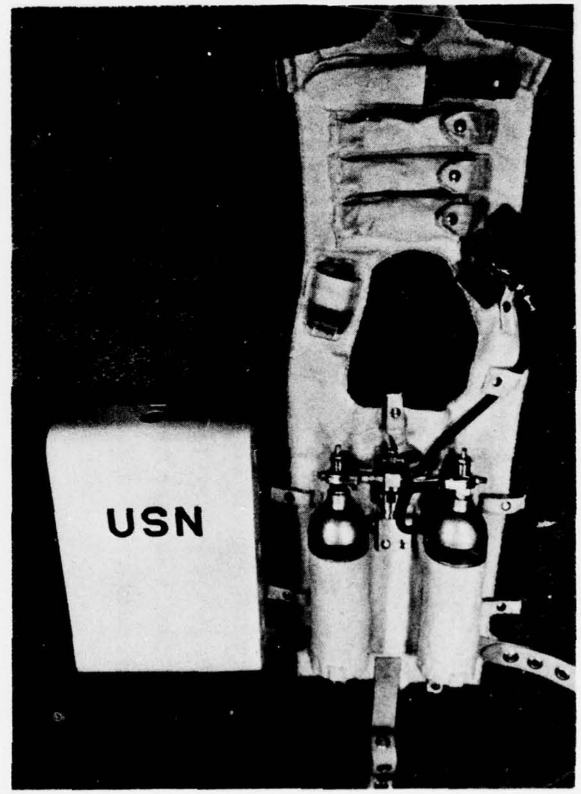

Figure 8. Rescue vest with backpack removed.

The in-water tests consisted of submerging a subject in full Navy flight gear and creating various degrees of shroud line entanglement at various depths. The subject was provided with a concealed scuba unit. In each test a rescue crewman wearing the prototype vest disentangled and rescued the downed pilot. Figures 9 through 13 on the following pages illustrate the underwater photographic documentation of various aspects of these tests.

For this specific project, all underwater photography was accomplished by two BioTechnology, Inc. divers utilizing hand-held equipment. This underwater equipment included the following:

(1) Nikon F 20 mm lens in an Ikelite™ submersible housing with a dome lens port. A Sekonic Marine II light meter, with Vivitar 192 and 292 syncronized strobes in an Ikelite™ housing was also used (Figure 14). This camera was the main camera for shooting action sequences. It shot black and white negatives as well as color transparencies.

(2) Nikonos III 28 mm lenses with a Gossen pilot light meter in an Ikelite™ submersible housing and a Vivitar 292 strobe in an Ikelite™ submersible housing with underwater disconnect capabilities (for available-light or strobe photography) (Figure 15). This camera was used for black and white negatives of overall action enabling the photographers to shoot more film during any given sequence.

(3) Nikonos III 28 mm Nikor underwater lens with a Sekonic L64 meter and an Oceanic 2001 strobe and arm was used as back-up underwater camera when the primary rigs were loaded with color film.

(4) Nikonos II 35 mm Nikor underwater lens with a L164 Sekonic meter. The basic responsibility of this camera was (1) available-light photography and (2) back-up equipment. This camera was equipped for underwater flash rigging.

In addition to the underwater equipment, the following surface photographic equipment was employed:

(1) Mamiya C220 twin-reflex camera with 8 mm or 6.5 mm f 3.5 lenses. This camera was used for all large format shooting where extreme enlargement of color or black and white prints was expected.

(2) Nikon F2-24 mm f 1.2 lens on a tripod. This camera was mounted at a high overall shooting position for black and white and color transparencies of deck activity.

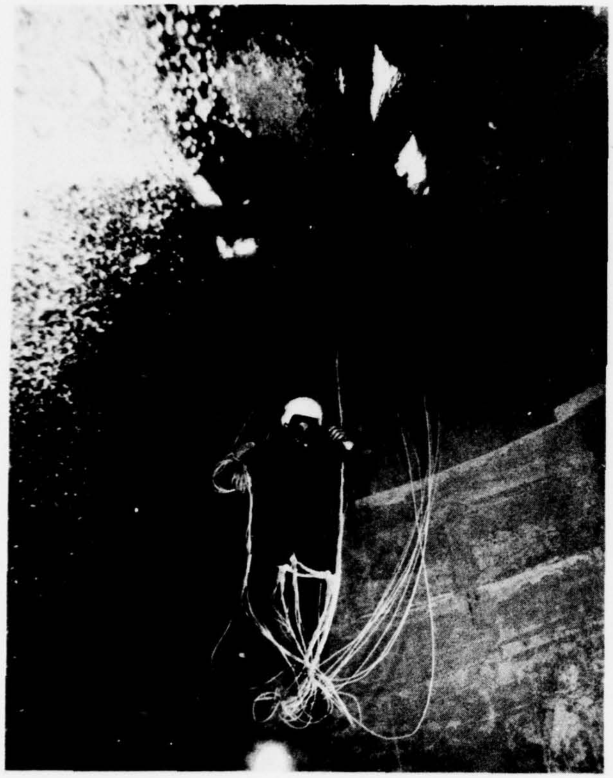

Figure 9. Aircrewman at 25 feet entangled in parachute shroud lines.

Figure 10. Rescue crewman disentangling parachute shroud lines.

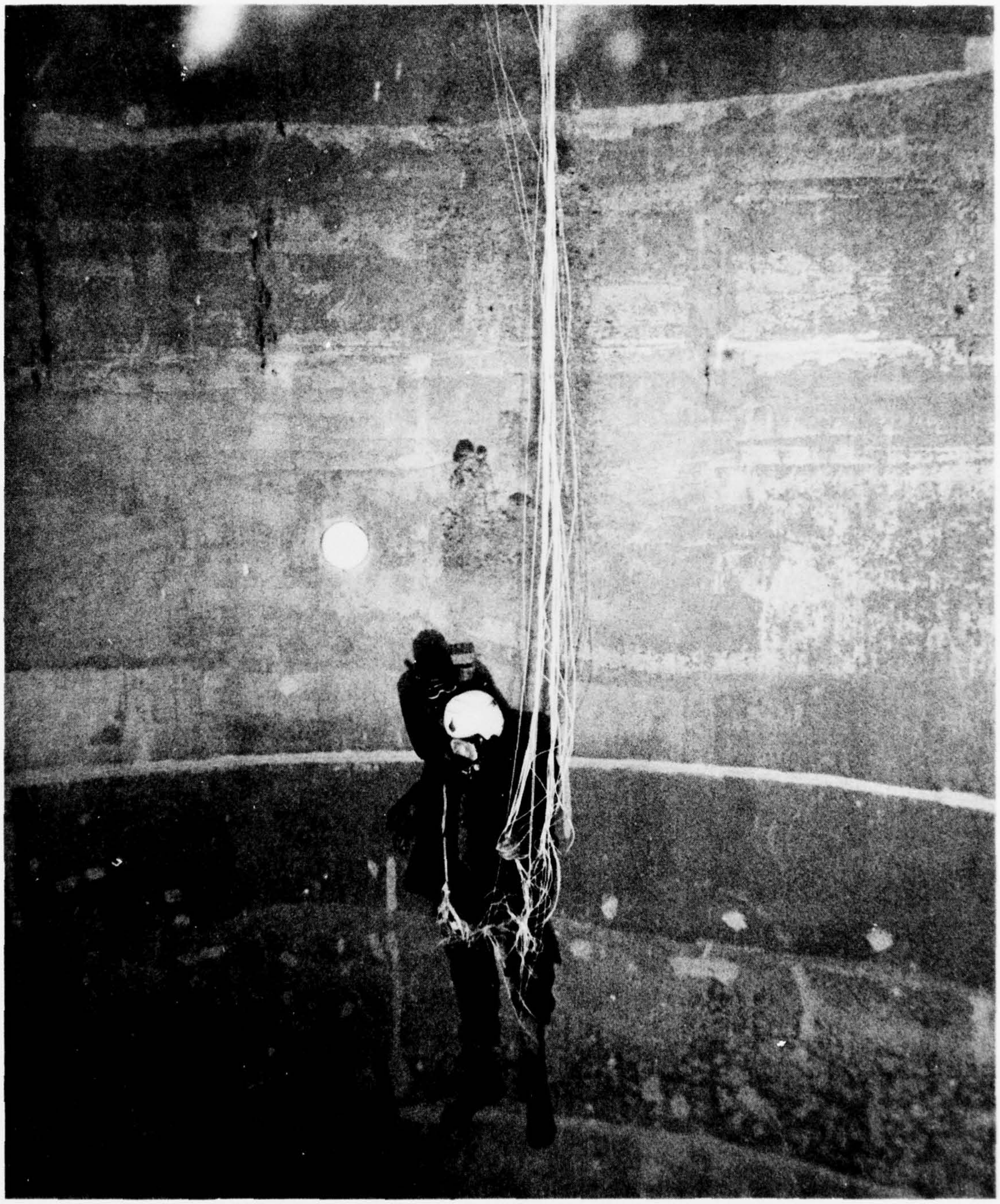

Figure 11. Rescue crewman attaching auxiliary flotation device.

Figure 12. Rescue crewman pulling survivor free of parachute prior to inflation of auxiliary flotation device.

Figure 13. Rescue crewman surfacing with survivor.

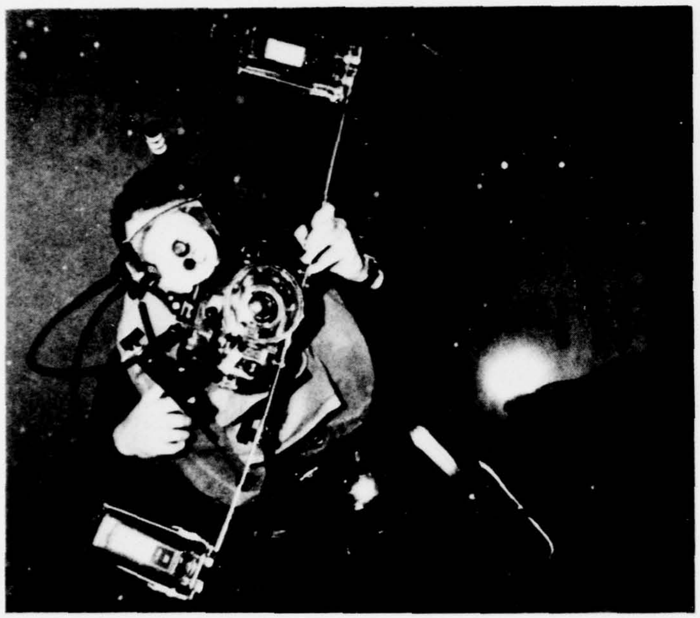

Figure 14. Underwater photographer utilizing Nikon F 20mm lens with Vivitar synchronized strobes.

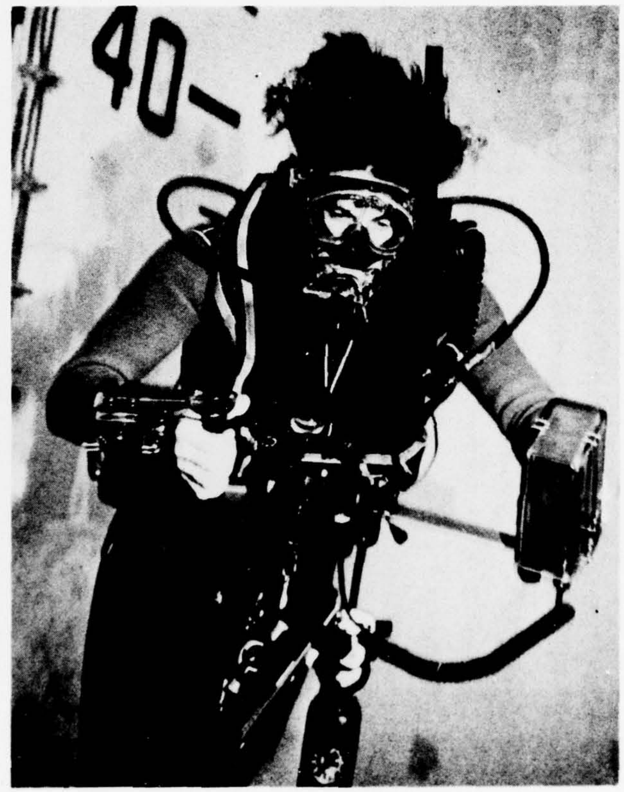

Figure 15. Underwater photographer with Nikonos III 28mm lens and single strobe with pilot light meter.

(3) Konica-50 mm lens. This camera was used for general photography of the exterior and interior of the facility.

While the photography shown in this report was by necessity, limited to black and white, the results of color photography proved equally successful. Only two slight problems were encountered during the photography of the underwater tests. The first involved poor subject positioning requiring the divers to photograph specific disentanglement shots directly in front of the Quartz-Iodide or porthole lights. The other involved photography immediately after moving the retrievable floor which stirred up some particulate matter resulting in backscatter from the flash. The movable platform floor significantly aided the underwater photographer, both in stabilization during the filming process and by providing a highly accessible place to store accessory and back-up equipment.

SUMMARY

This study of the physical and safety features of the Navy UnderseaWeapons Tank showed it to be an ideal facility to test and document in-water research. Specific problem areas of immediate interest within the scope of naval aviation for which this facility could be used include:

1. Evaluating the effectiveness of personal aircrew flotation and survival equipment
2. Analysis of problems associated with underwater ejection seats
3. Testing of in-water rescue devices worn or used by SAR aircrewmen
4. Analysis and documentation of problems and possible solutions dealing with underwater escape from a submerged helicopter.

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)

An Evaluation of the Navy Undersea Weapons Tank for Testing Aircrew Escape, Survival, and Rescue Procedures and Equipment

5. TYPE OF REPORT & PERIOD COVERED

Final

6. PERFORMING ORG. REPORT NUMBER

N/A

7. AUTHOR(s)

Martin G. Every
Michael C. Brody

8. CONTRACT OR GRANT NUMBER(s)

new N00014-77-C-0253

9. PERFORMING ORGANIZATION NAME AND ADDRESS

BioTechnology, Inc.
3027 Rosemary Lane
Falls Church, Virginia 22042

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

NR 207-007

11. CONTROLLING OFFICE NAME AND ADDRESS

Biophysics Division (Code 444)
Office of Naval Research
Arlington, Virginia 22217

12. REPORT DATE

September 1977

13. NUMBER OF PAGES

17

14. MONITORING AGENCY NAME & ADDRESS (If different from Controlling Office)

15. SECURITY CLASS. (of this report)

Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

N/A

16. DISTRIBUTION STATEMENT (of this Report)

Distribution of this report is unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

In-Water Survival	Navy SAR
Aircrew Escape	Navy Undersea Weapons Tank
Aircrew Rescue	In-Water Test Facility

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report evaluates the Navy Undersea Weapons Tank, White Oak, Maryland to determine its suitability as a test facility to conduct and document research relating to in-water escape, survival, and rescue following an aircraft or helicopter mishap. After consideration of factors such as safety, suitability for experimentation, data recording, and emergency medical care, this facility was shown to be excellent for this type of testing. Much of the photographic documentation shown in this report was accomplished during tests involving underwater parachute entanglement and rescue of live subjects.